

Date: Monday October 4, 2004

Time: Noon - 1pm

Place: N245, Room 215

Speaker:

Jonathan Fortney

Title: Helium Phase Separation and the Evolution of Saturn (and Other Giant Planets)

Abstract:

The planet Saturn is currently over 50% more luminous than one would predict for a homogeneous adiabatic hydrogen-helium planet. However, homogeneous adiabatic evolutionary models of Jupiter predict the planet's current luminosity fairly accurately. Recently we have attempted to explain this discrepancy by calculating detailed evolutionary models of Jupiter and Saturn that include a phase separation of helium from liquid metallic hydrogen in Saturn's deep interior. As has been known for some time, if this immiscible helium rains down to deeper layers inside the planet, this process can be a substantial additional energy source. We test predicted high-pressure hydrogen-helium phase diagrams and place constraints on the helium phase separation process. We also extend our calculations to investigate the effects that helium phase separation has on various hypothetical extrasolar giant planets (EGPs) in the mass range from 0.15 to 3.0 Jupiter masses, for ages up to 10 Gyr. The energy provided by "helium rain" leads to planet luminosities twice the value calculated with homogeneous models, somewhat larger radii, and a several billion year delay in the gradual sinking of ammonia clouds in their atmospheres. The detectability of these old low-mass EGPs will also be discussed.